ENGINEERING CASE LIBRARY

ECL 38

DYMO INDUSTRIES, INC. (A)

Design of a Tapewriter Component

In April, 1964, Georg Bremer, a design engineer at Dymo Industries, Inc., in Berkeley, California, began working on the design of a new tapewriter or labelmakers.

Georg had graduated in 1962 from the University of Sao Paulo in Brazil. The program he had followed included four years of studies in mechanical engineering followed by a fifth year of specialization in "production engineering," which included such things as economic analysis and designing for high-volume production. He had also accumulated one and one-half years experience designing molds for a plastics company under the University's cooperative program. He had come to work at Dymo in September, 1962.

Dymo's product line is based upon a series of tapewriters which emboss symbols (letters, numbers, etc.) on plastic tape. Dymo also manufactures the tape, a particular variety of vinyl which stress-whitens. After embossing, the raised symbols appear white against a colored background. Tapes are adhesive backed and the labels find a wide variety of uses. The labelmaker line includes models intended for home, office and industrial use. Tape widths ranging from 1/4 inch to 3/4 inch are used; all but the model employing 3/4 inch tape are hand-held. Typical tapewriters are shown in Exhibit A1.

Prepared in the 1965 Summer Design Workshop at the University of California, Berkeley, by John A. Alic under the direction of H. O. Fuchs with financial support from the National Science Foundation. Revised and reproduced in the Engineering Case Program, Stanford University, Stanford, California.

Dymo Industries has grown dramatically during its short history. Since the acquisition of the basic tapewriter patents, sales have grown from $0.6 million during the 1959 fiscal year to $29.8 million for the 1964 fiscal year. The first three quarters of 1964 showed a further 29% increase in sales. Employment increased from 120 in 1960 to more than 1600 in 1964. While some of the growth has resulted from the acquisition of subsidiaries, a large part is the result of increased sales of tapes and embossing tools. In 1964, Dymo operated manufacturing plants in six countries and tape embossing wheels for seven alphabets were available.

In a typical Dymo labelmaker tape is fed from a magazine holding the tape roll through the embossing wheel by a mechanism which embosses a symbol and advances the tape a certain distance each time the handle is operated. The embossing wheel is a two-piece molded plastic die set. Both the pieces are discs; they are fastened together only at their centers and the tape passes between the two beyond this central hub. The upper disc contains female impressions of the characters near its circumference. The male dies for the characters are each at the end of an individual radial strip; together these form the lower disc. When the embossing handle is pressed the male character is forced upwards into the mating female depression while the tape is between the two. A typical M-10 wheel contains 42 symbols; the number varies depending on the size of character desired and the widths of the particular non-alphabetical symbols included.

The new tapewriter Georg Bremer was designing had been designated the M-10. It was to retail for $14.95 and be capable of embossing either 1/4 inch tape or 3/8 inch tape, whichever size was loaded into the tool. The dual width feature would make the M-10 unique; its enhanced versatility would be a most desirable sales feature in the office supplies market for which it was intended.

Georg helped the project engineer -- who bore overall design responsibility -- to write the specifications upon which the design was based. The important features of the design were decided upon by the engineers involved after discussion with Dymo's market researchers and following certain management directives. Important requirements relevant to the dual tape-width specification were: that cost be such that the labelmaker could be sold for $14.95, and that the most recently embossed symbol be visible upon leaving the embossing wheel.

Dymo's labelmakers depend on friction drive via a rubber wheel to feed the tape; there must be no slippage or symbols will not be uniformly spaced. The tape must be guided on its edges at entrance and exit to the embossing wheel so that symbols will be centered. Its upper and lower surfaces must also be guided so that the tape will always follow the same path; if the tape were allowed to buckle at some point between the drive wheel and the embossing station, symbols would be mis-spaced.

Dane Pederson, Chief Design Engineer at Dymo, had been thinking about the dual tape-width problem prior to the inception of the M-10 design. At first, he considered a simple dual level track in which the tape would be held flat by leaf springs, as shown in the sketch of Exhibit A2. Problems

with such a configuration were expected. It would be difficult to use springs to hold the 1/4 inch tape flat in its groove and also to hold the 3/8 inch tape flat at a higher level when it was supported only on its edges. In addition it was felt that the variation in friction as a result of different spring forces at the two levels would cause spacing problems -- buckling of the tape or slippage of the drive wheel, particularly since the forward spring would have to pass over the embossed symbols. Georg Bremer did not like springs, especially short springs, because there was so much variability in force with changes in length and material characteristics.

Although it would be possible to adapt a labelmaker to dual tape-widths by using removable inserts on either side of the embossing wheel as tape guides, Georg rejected this approach for several reasons, the most important being that anything removable can get lost. When he considered the alternative -- a pair of guides of some sort moving between two positions within the body of the tapewriter -- he decided that guides which slid up and down in grooves or slots would be unsatisfactory unless the parts were made to very close tolerances to minimize the possibility of sticking or cocking. The required tolerances might be prohibitively expensive.

Georg also felt that it should be possible to switch the tape guides by a single manipulation so that one guide would always be set for the same tape size as the other. He then decided to join a pair of guides with a bridge piece pivoted halfway between the two, over the embossing wheel. This was the origin of the tilting "see-saw" tape guide or tape selector used in the M-10.

Exhibit Al

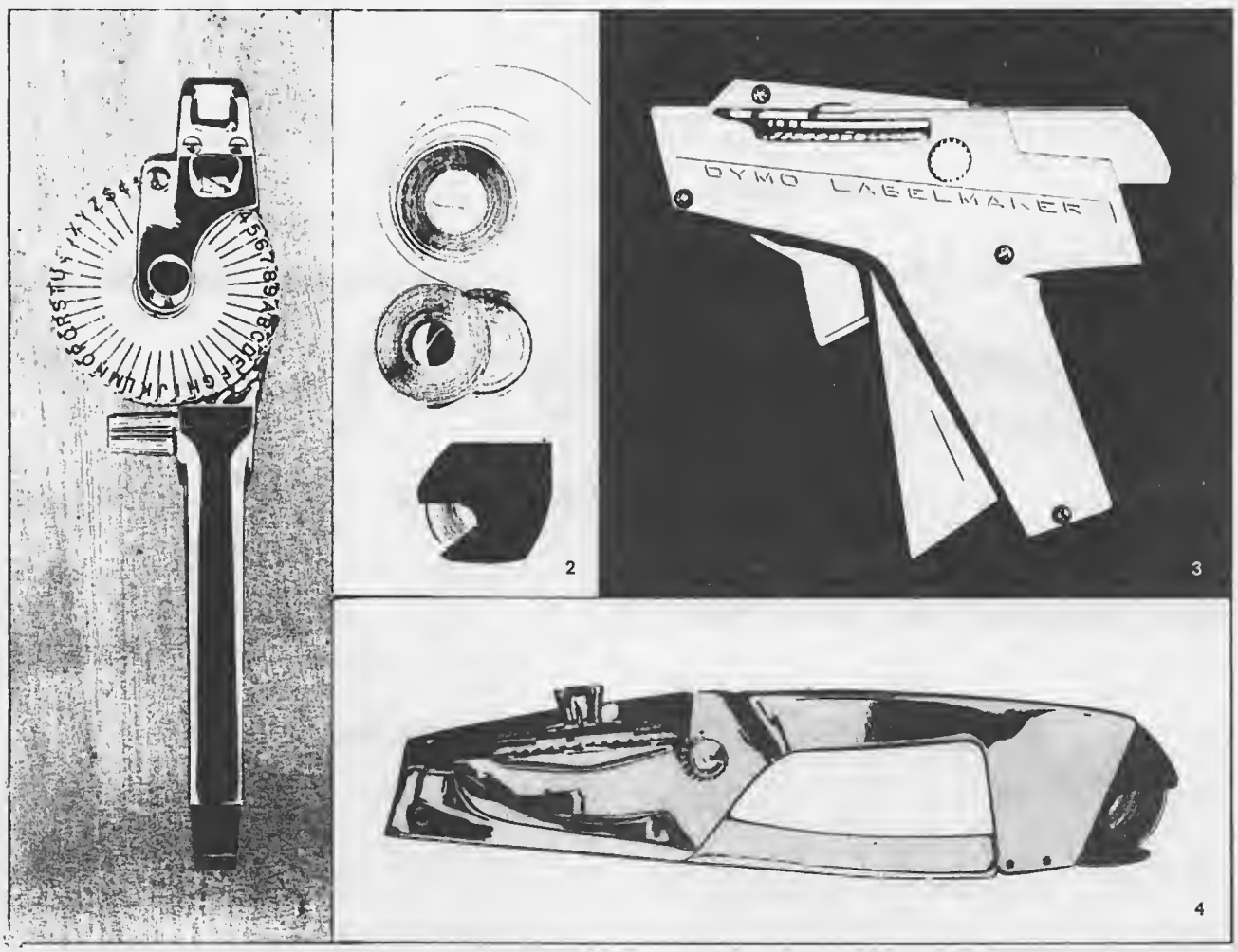
Dymo Tapewriters

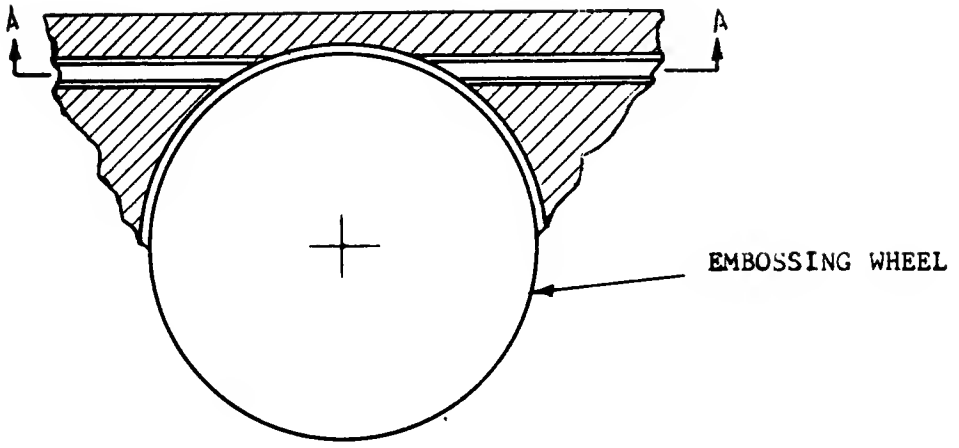
THE DYMO LABELING SYSTEM

Millions of people in plants, offices, and homes throughout the world are familiar with the Dymo System of permanent, on-the-spot-labeling. Dymo labels, embossed in clear white letters on plastic, self-sticking tapes, appear on office files and filing cabinets, personal and corporate property, electrical circuitry, instrument panels, name badges—practically wherever there is a need for identification.

Industrial TAPEWRITER and home LABELMAKER embossing tools are produced by Dymo in models, sizes and prices appealing to the broadest possible range of consumers. Individual embossing tools, kits containing complete "do-it-yourself" labeling equipment, and tapes in various widths, colors and materials offer the dealer an attractive merchandising array.

1 Model M-29 TAPEWRITER embossing tool.
2 Dymo embossing tapes and tape magazine.
3 Model M-4 home LABELMAKER tool.
4 Model M-55B TAPEWRITER embossing tool.





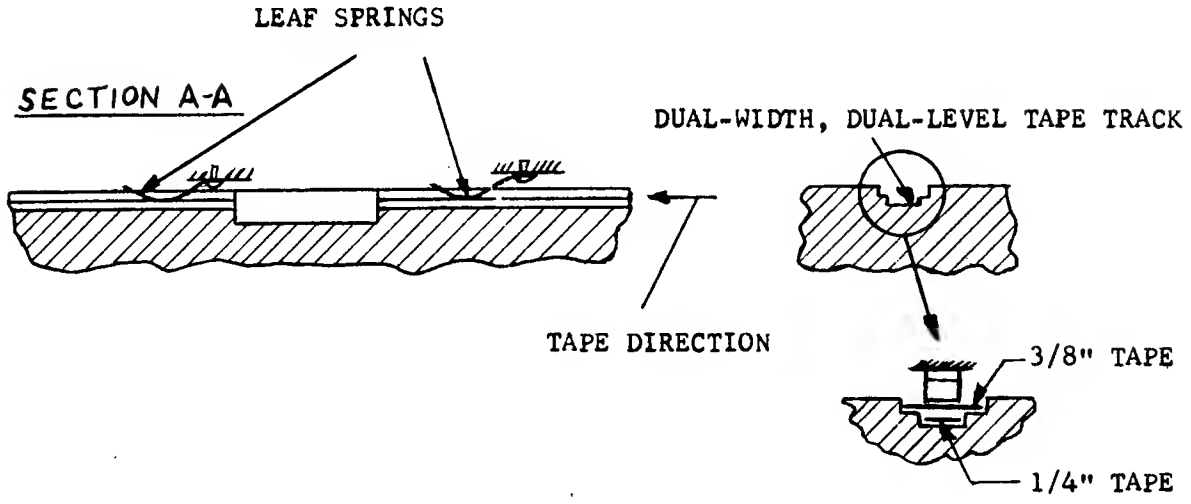


Exhibit A2: Sketch of the First Idea for a Dual-Width Tape Guide

DYMO INDUSTRIES, INC. (B)

Design of a Tapewriter Component (Continued)

After Georg Bremer arrived at the "see-saw" idea for the tape guide on the M-10 labelmaker, he began thinking about and sketching possible configurations. The problem was to guide tapes of both widths through identical paths and through the embossing wheel. Eventually, he evolved the design shown in the sketches of Exhibit B1 and the drawings of Exhibits B2 and B3 and added it to the 4:1 layout he was making of the entire tool. The location of the see-saw relative to the other parts of the tool is shown in Exhibit B4.

From the inception of its design, the two body halves of the M-10 were planned as metal die castings (zinc or aluminum) and the tape door and the two operating handles were to be plastic. While styling the machine, Dymo's industrial designer asked Georg if a plastic part could be incorporated on top of the machine at the front to follow the lines of the tape door. Originally, the two body halves would have extended over the top of the tool in front of the door. When Georg studied the industrial designer's request, he could visualize a part of the see saw as this plastic piece. He was then able to design the see-saw as two molded plastic parts snapped together at the hinge. Georg stated that utilization of the elastic properties of plastic here and at the detent used to hold the see-saw in position were two of many details which helped the M-10 meet its cost goal. The particular plastic specified, Cycolon, was used in Dymo's other tapewriters.

Georg feels that any single part in a machine should do as many jobs as possible, so he incorporated the tape cut-off blades in the cover (fixed) part of the see-saw. The tape is pressed against these blades when the cut-off lever is operated. The forward blade severs the tape and its backing while the second slices through the tape but leaves the backing intact forming a tab by which the backing can be pulled away from the adhesive surface. The window in the top of the cover is for viewing the symbol most recently embossed. Its size and location dictate in part the configuration of the forward tape guide. A knob on the moving see-saw piece projects through a slot in the right side body half for selecting the desired tape width.

While working on his first layout, Georg added a third tape guide, this one a set of simple dual-width dual-level slots in the body of the machine. They were located between the tape magazine and the see-saw to ensure dependable threading of a new tape. The tape loading procedure is described in Exhibit B5. After passing through this first guide, over the rubber drive wheel, and through the first of the see-saw guides, the tape is constrained at two points while being pushed through the embossing wheel towards the frontmost guide. The leading edges of this guide are beveled to direct the tape in.

When Georg had finished his layout, draftsmen made detailed drawings from it under his direction. In the case of the two see-saw parts, he did much of the drawing himself since a knowledge of plastics molding techniques was needed in assigning critical dimensions and tolerances. Then a new "checking layout" was made from the details only, to be sure they would fit together. Before making a prototype, templates of all moving parts were cut out and placed in position under the layout to functionally check their motions. When this stage was satisfactorily completed a prototype was made. The parts were made of the materials specified for production but were machined rather than cast or molded. This work was hired out to several machine shops, each of which made some of the parts to Dymo's drawings. Georg explained that if one shop was given the whole job, they might make a tapewriter that fit together rather than one in which each part conformed to the drawings.

The prototype was approved in August and work could begin on dies and molds. Dymo purchases the two see-saw pieces, and others, from a firm which specializes in molding plastics. They in turn contracted another specialty firm to make the molds. The dimensioned detail in Exhibit B2 shows many changes, as indicated by the circled letters. While some of these resulted from a change in the size and location of the Dymo name and model number molded into the top of the cover, others are changes in dimensions and tolerances which were made to the drawings when it was found that the original tolerance was unnecessarily restricting or that the parts as received from the molding company were outside the print dimensions but still functionally satisfactory.

After the M-10 went into production, Georg no longer had a voice in design changes except as a consultant. The tapewriter was turned over to a project engineer in charge of "work in process" in order to free the the design engineer and the original project engineer for work on new designs.

The M-10 went into full production at an initial rate of 1000 to 1200 units per day on March 1, 1965. With chrome plated body halves, the tool sells for $19.95. With painted body halves it is called the M-14 and the price is $14.95.

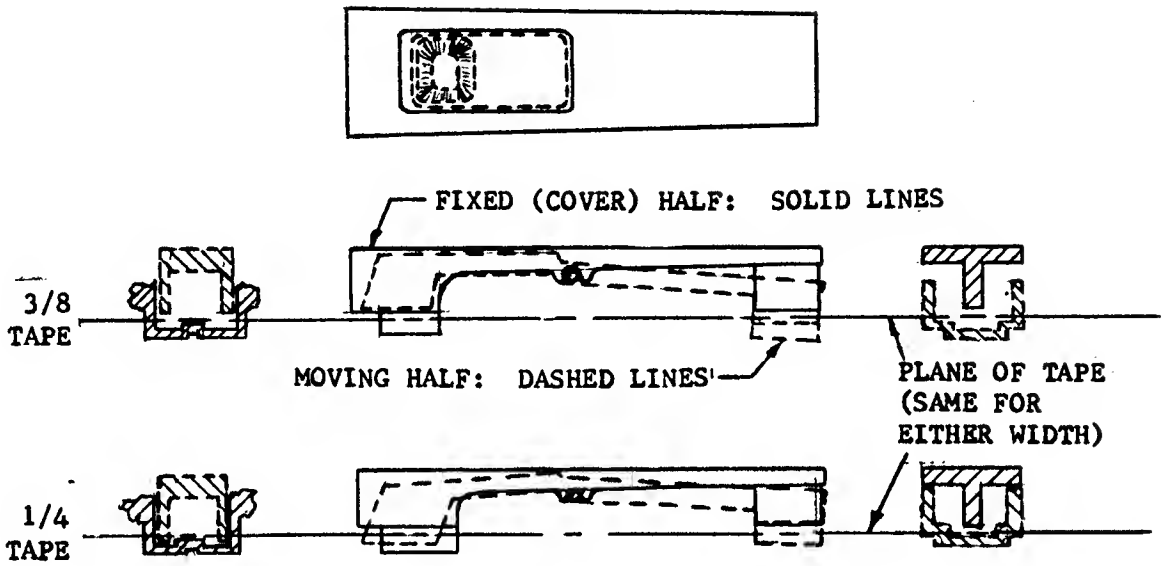


Exhibit B1: Sketch of the See-Saw Tape Guide

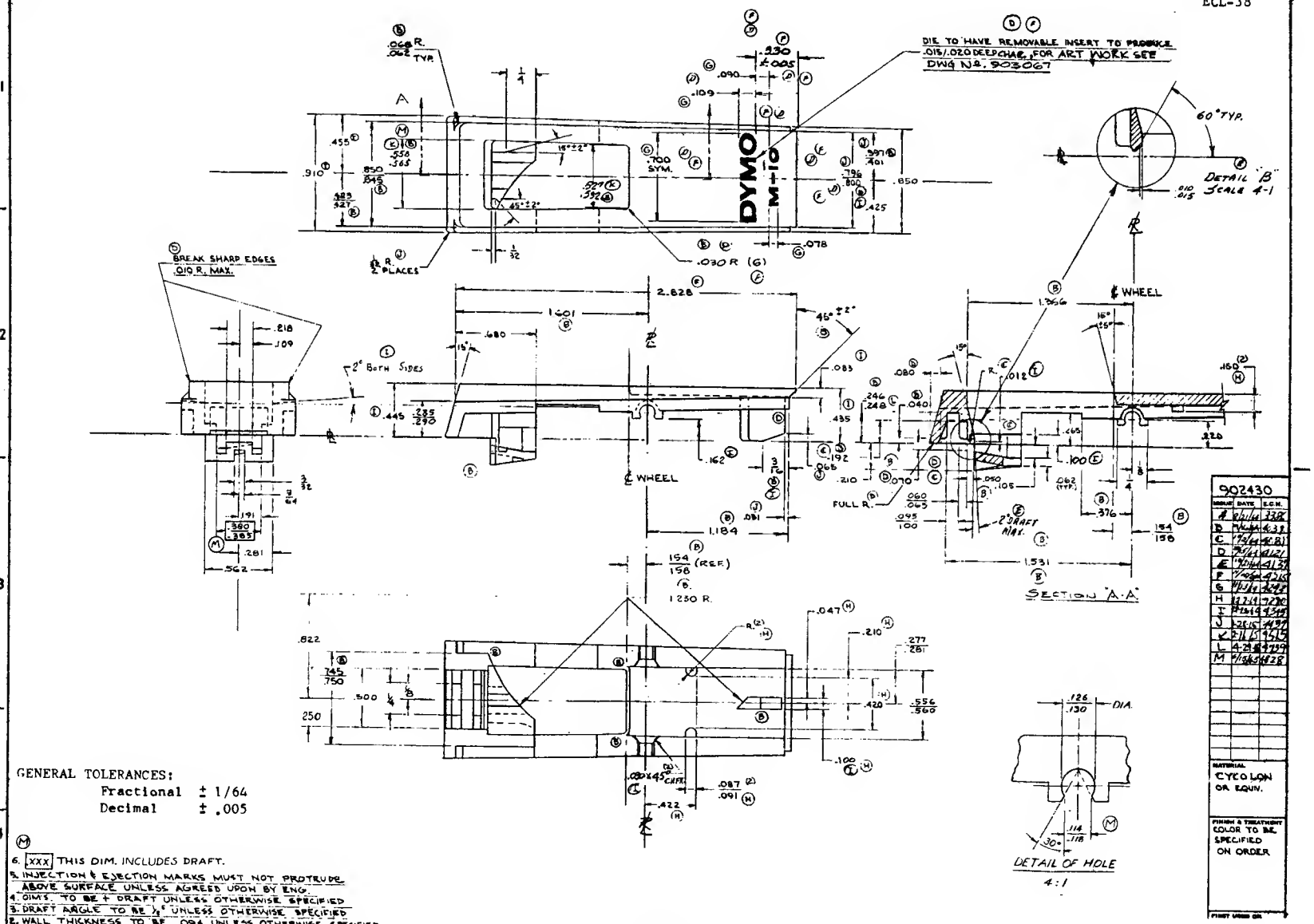


Exhibit B2: Dymo's Detail Drawing of the Cover

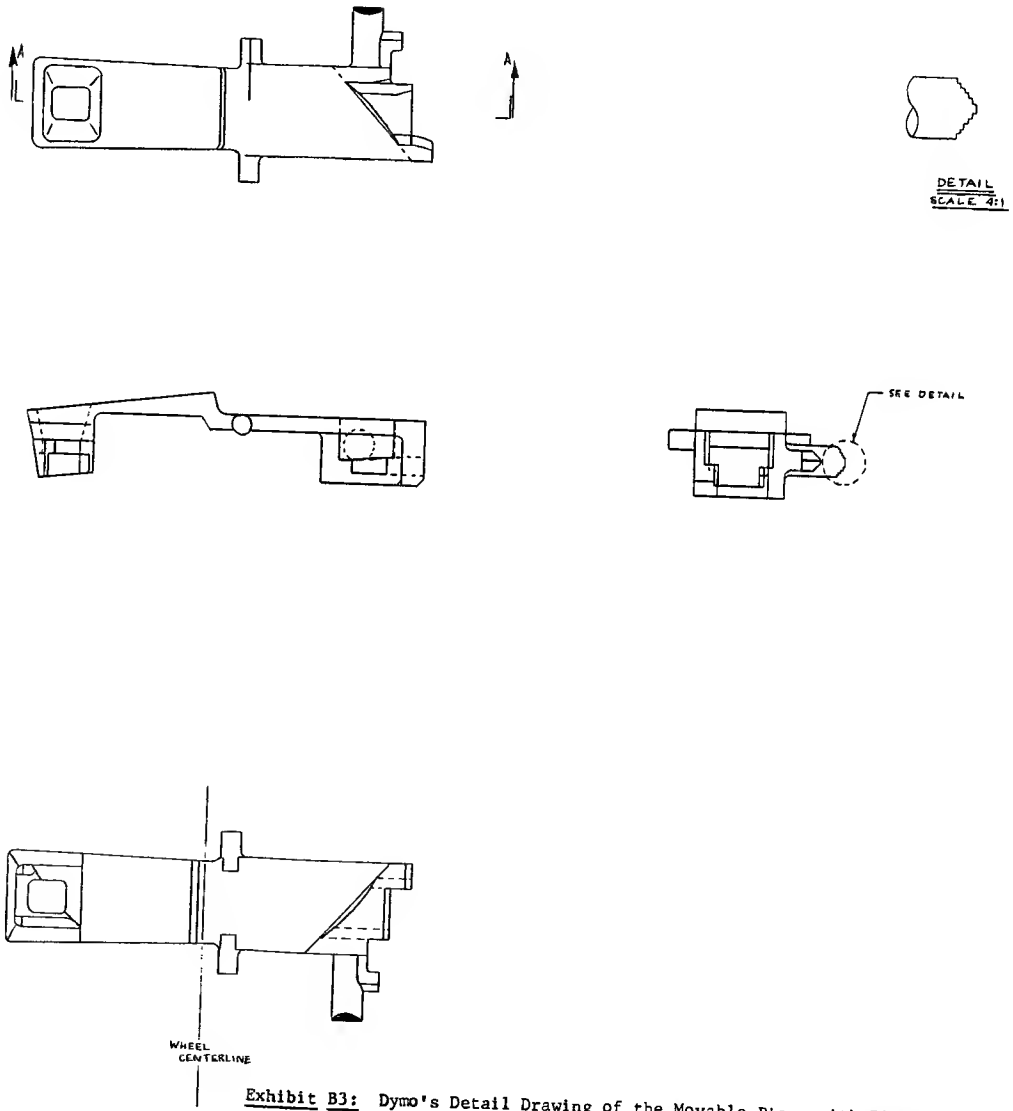


Exhibit B3: Dymo's Detail Drawing of the Movable Piece with Dimensions Removed

Exhibit B4

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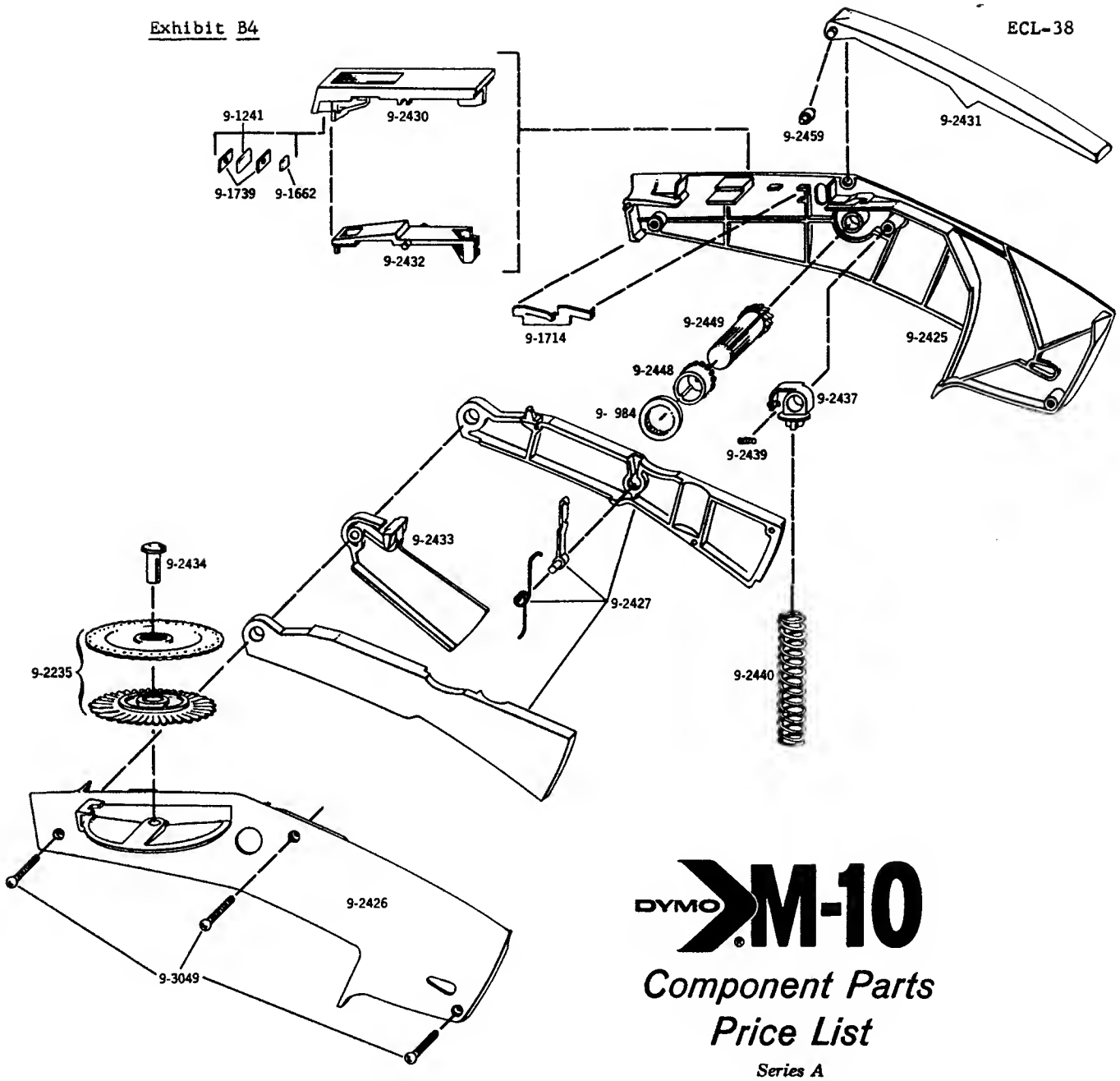

DYMO M-10

Component Parts Price List

Series A

9- 984	TIRE	.20
9-1241	STRIPPER	.15
9-1662	BUMPER	.20
9-1714	INDEX SPRING	.15
9-1739	BLADES (2) EA.	.20
*9-2235	EMBOSSING WHEEL	9.85
9-2425	RIGHT HAND BODY	4.50
9-2426	LEFT HAND BODY	4.50
*9-2427	HANDLE ASSEMBLY	1.50
9-2430	M10 COVER	1.00
9-2431	DOOR	.50
9-2432	TAPE SELECTOR	.50
9-2433	TRIGGER	.45
9-2434	WHEEL PIN	.10
9-2437	INDEX PAWL	.25
9-2439	PAWL SPRING	.08
9-2440	MAIN SPRING	.15
9-2448	FEED ROLLER	.25
9-2449	RATCHET	.75
9-2459	IDLER	.20
9-3049	SCREWS (3) EA.	.05

*SUPPLIED AS AN ASSEMBLY ONLY.

The Company reserves the right to make changes or additions in the design, or improvements on its products without imposing any obligation upon itself to install them on its product previously manufactured. All prices subject to change without notice.

Exhibit B5

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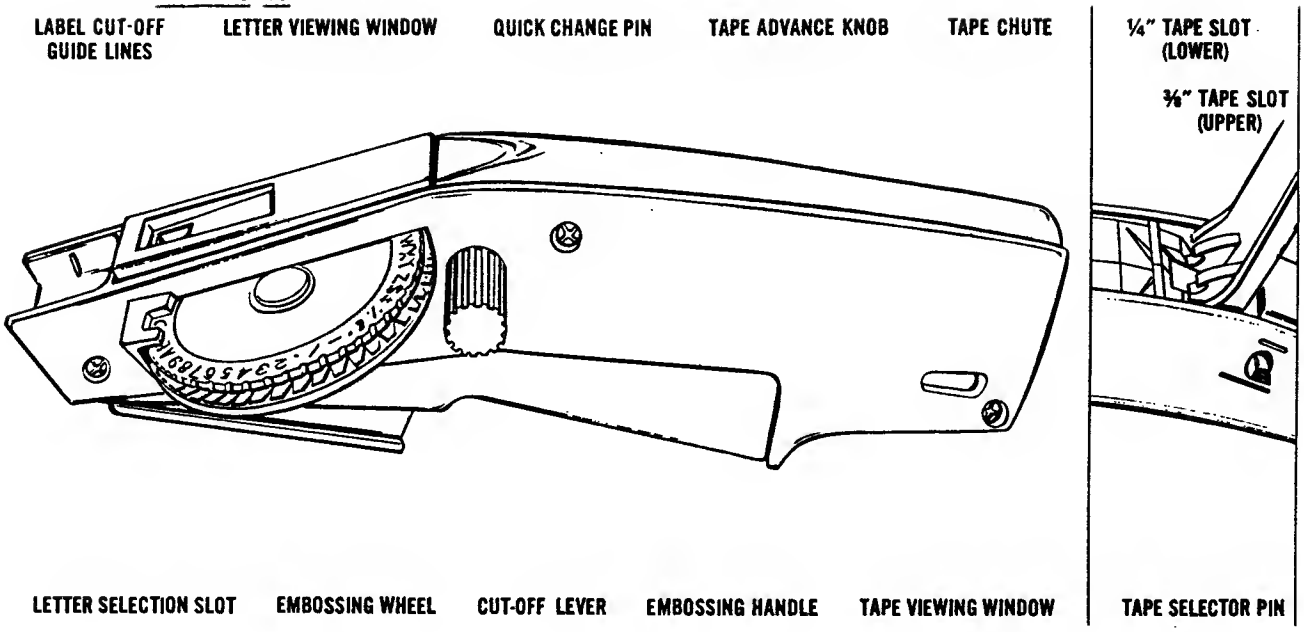


TO USE TAPE SELECTOR

THE TAPE SELECTOR feature on your M-10 or M-14 TAPEWRITER enables you to use your choice of ¼" or ⅜" width embossing tape. After selection of tape width desired, move TAPE SELECTOR PIN (M) up (to narrow indicator) for ¼" tape or down (to wider indicator) for ⅜" tape (Fig. 1).

TO LOAD

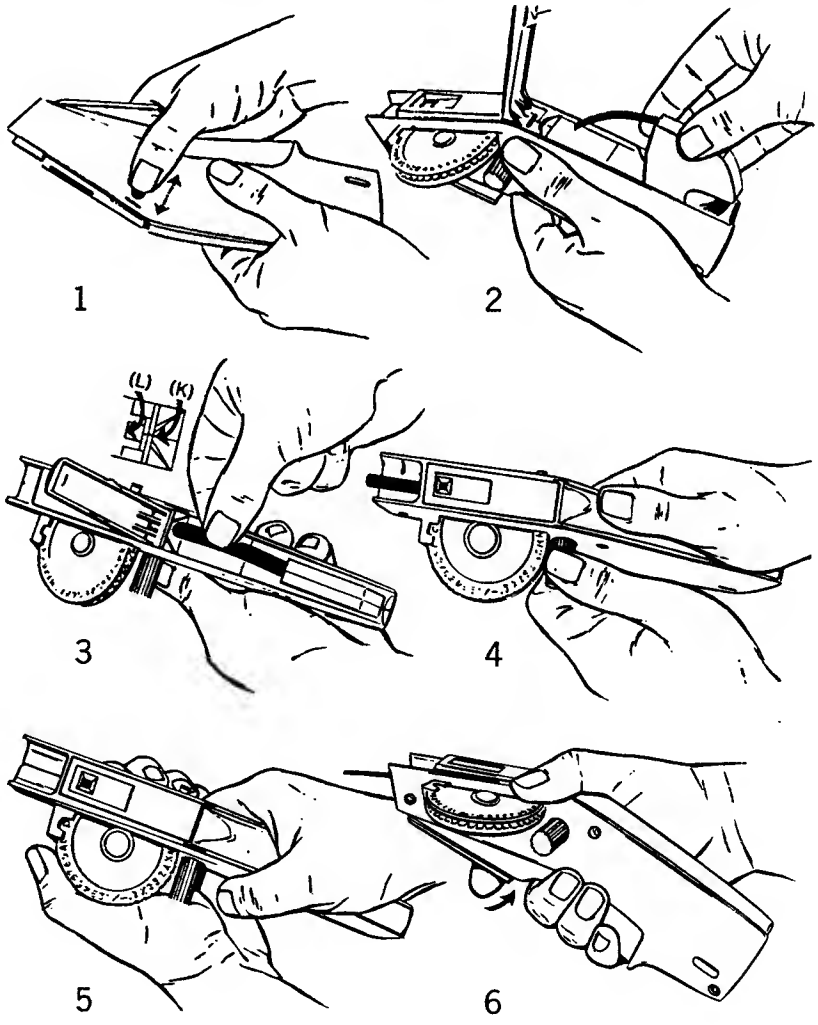
Select a tape magazine. Pull out about 3 inches of tape. Open TAPE CHUTE (E), insert magazine in chute (Fig. 2) and thread front of tape strip into slot (K) for ¼" or (L) for ⅜" tape use (Fig. 3). Close tape chute lid, thread tape forward into proper slot until tape engages in feed roller. Turn TAPE ADVANCE KNOB (D) forward until ¼" of tape extends past front of tool (Fig. 4). Pull up cut off lever (H) (Fig. 6), remove small piece of cut off tape . . . you are now ready to emboss label.

TO MAKE THE LABEL

Dial the EMBOSSING WHEEL (G) until desired letter appears in letter selection slot (F) (Fig. 5). Squeeze EMBOSSING HANDLE (I) firmly up into machine. Release. Repeat for each letter desired. To space between words squeeze EMBOSSING HANDLE (I) gently only until you hear a click . . . no farther . . . then release, then emboss your next letter.

TO CENTER AND CUT OFF

After you have completed your last letter, advance tape with TAPE ADVANCE KNOB (D) until last letter aligns with CUT-OFF GUIDE LINES (A) at top front of tool. Pull up CUT-OFF LEVER (H) firmly while holding tool as illustrated (Fig. 6). Release CUT-OFF LEVER (H), pull out label. Your message is now centered on the tape. Notice the small tab at the right end of the label . . . this facilitates removal of tape protective backing strip. You are now in starting position for next label.



DYMO INDUSTRIES, INC.

Instructor's Note

The Dymo Case can be used in various ways. Among these are:

1) As an illustration of the design procedure followed by a a firm with a relatively small engineering department. Here we see a single engineer setting an entire design down on paper, even to some of the detailing and dimensioning. The evolution of the design is outlined, together with the checks made at each stage. The informal approach at Dymo may be contrasted with examples from other cases or from the instructor's own experience.

2) As a design problem. After reading the (A) part, the student may be assigned the task of sketching a design based on George Bremer's see-saw idea. Then the student designs may be compared with that evolved by Bremer in part (B).

3) As a dimensioning problem. The student assignment might be to define the part shown in Exhibit B-3, indicating where dimensions should be placed.

Other uses for the case and questions for discussion will no doubt present themselves to the instructor. George Bremer arrived at the see-saw idea via a straight-line procedure, considering single successive alternatives. If the class is critical of this approach, they may be challenged to come up with a better idea using a more formal and sophisticated design process.

The case might also be used, in a still broader way, as a basis for the conceptual redesign of the tapewriter as a whole or for the styling of a tapewriter.